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LATENT-HEAT BODY
[Latentwärmekörper]

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Latent Heat Body /1*

The invention concerns a latent-heat body with a paraffin-based material for the storage of latent heat, accommodated in a carrier material provided with capillary-type recesses, the carrier material consisting of an organic plastic or natural material.

A porous foamed material is known as a carrier material from German utility model 84/08,966. But, in the case of this foamed material, it is not possible to achieve the desired structural strength even in the heated state of the latent-heat storage material. Moreover, the porous foamed material cannot be directly impregnated with the material for the storage of latent heat. Special measures, such as squeezing it out, must be taken.

Starting there as a point of departure, the invention deals with the technical problems of producing a latent-heat body, which is easy to manufacture but highly efficient, i.e. exhibits a high capacity for the storage of heat and also sufficient structural strength in the heated state. Another goal is for the carrier material to be filled with or absorb the material for latent-heat storage as automatically as possible. It is also important, already on the basis of the properties of the carrier material, to achieve a capacity with regard to supporting the material for storing latent heat.

These technical problems are solved above and essentially by the object of claim 1, in which provision is made for the carrier material to be assembled, for example, by cementing, from separate carrier-material elements that have intrinsic structural strength /2
or, in conjunction with the material for latent-heat storage, lead to structural strength.

It is thereby important for the invention that a certain coherence exist between the carrier-material elements even in the absence of latent-heat storage material, so that, in the case of the carrier material, it will be a matter of one or more structures consisting respectively of a plurality of cohering carrier-material elements. The elements of the carrier material are composed, according to the invention, in such a way that capillary recesses

*Numbers in the margin indicate pagination in the foreign text.

for the latent-heat storage material are formed between them, which can exhibit a fissure-like form. The above-described capillary recesses, due to their capillary pulling effect upon a fluid, permit a largely self-acting uptake or absorption of the fluid by the carrier material as well has a high capacity for retaining the same. This effect is advantageously utilized for the latent-heat body according to the invention by the fact that the proposed latent-heat storage material based upon paraffin, to which one or more additives indicated in this application can be added, is liquefied by heating until self-acting suction can be observed. By preference, the latent-heat storage material can be heated thereby to a temperature that lies above the highest melting temperature of the individual paraffins and additives contained therein. The latent-heat storage material is thereby liquefied to such a great extent that it can be taken up automatically until the carrier material is completely saturated with the same. Resulting from this activity is the advantage that it is possible to do away with expensive and therefore cost-intensive technological procedures involving input of energy, particularly of mechanical energy.

The composition leading to a strong bonding together of the carrier-material elements is at the same time suitable for setting the size of those recesses remaining between the elements of the carrier material and influencing the structural strength desired. /3

Due to the fact that the size of the recesses can be set, there is furthermore the possibility that a size can be set for the recesses, as a function of the boundary or surface tension of the latent-heat storage material, which is optimal with regard to the greatest possible storage capacity and a capillary action that is at the same time sufficiently high.

Entering into consideration, as carrier materials, are organic materials such as plastic or cellulose. It is also preferred that a carrier-material element exhibit an intrinsic capillarity, for example, a cellulose fiber, perhaps a wood fiber, which itself yields an essentially finer capillary space than the capillarity formed between two fibers. It is important, furthermore, that the latent-heat storage material itself form homogeneously distributed hollow structures. These are of great importance for the performance and response behavior of the latent-heat body. Such hollow structures first produce yielding spaces in the course of the volume change during heating or cooling. These volume changes

can frequently lie in the size range of 10% of the volume. It is moreover possible to employ fibers with a very different length and very different diameter as carrier-material elements. Also suitable are, in particular, ceramic fibers, mineral wool, plastic fibers as well as further suitable fibers such as,for example, cotton or sheep's wool. The ceramic fibers used preferably consist essentially of Al_2O_3, SiO_2, ZrO_2 and organic additives, in which /4 case the portions of the components can vary greatly. According to the portions selected, the densities of the ceramic fibers also vary greatly and thereby lies preferably within a range between 150 and 400 kg/m^3. As for mineral wool, the focus is on rock wool with and without the addition of duroplastic artificial resins, which can further contain quantities of glass fibers. The density will vary as a function of the composition selected in a given case and thereby lies preferably within a range between 200 and 300 kg/m^3. Plastic fibers suitable as carrier-material elements preferably exhibit base materials such as polyester, polyamide, polyurethane, polyacrylonitrile or polyolefins. It is especially preferred for that purpose that the latent-heat storage material be a paraffin, such as that described in DE-OS 4,307,065. The content of this earlier publication is thus incorporated in its entirely into the disclosure in this application, also for the purpose of including features of this prior publication into the claims of the present application.

Such a paraffin exhibits crystalline structures in its solidified state, which are modified by a structural additive, preferably in the form of hollow structures, such as hollow beads. That makes it possible to make a definitive improvement in the response behavior of the latent-heat storage material during the input of heat. The material for the storage of latent heat, such as paraffin, thereby takes on a uniformly porous structure. With the application of heat, easily melting components of the latent-heat storage material will be able to flow through the structures provided by the material itself. A type of microconvection can also be optionally imposed with regard to air inclusions. /5 The result is also a mixing through with a high degree of effectiveness. Also resulting, furthermore, is an advantage relative to the already addressed expansion behavior during phase changes. The structural additive is preferably dissolved homogeneously in the material for the storage of latent heat. In particular, structural additives, such as those on the basis of polyalkyl methacrylates (PA-MA) and polyalkyl acrylates (PAA) have

proven to be effective. Their crystal-modifying action is called forth by the fact that the polymer molecules are likewise built into the growing paraffin crystals and that the further growth of this crystal form is prevented. Due to the fact that the polymer molecules are also present in paraffins in the homogeneous solution, in associated form, paraffins are able to grow on the special associates. Hollow beads are formed, which are no longer capable of the formation of networks. As a result of the synergistic action of this structural additive upon the crystallization behavior of the paraffins, a formation of hollow cavities is achieved, and thus an improvement in the ability of the heat-storage medium paraffin (for example, for air or steam trapped within the latent-heat storage bodies or for liquefied phases of the latent-heat storage material, i.e., the paraffin itself) to flow through, compared with that of paraffins that have not been compounded in this way. Generally suitable as structural additives are also ethylene - vinyl acetate copolymers (E, VA), ethylene - propylene copolymers (OCP), diene - styrene copolymers, both as individual components as well as in mixtures, as well as alkylated naphthalenes (Paraflow). The portion of structural additives begins with a fraction of percent by weight, realistically at about 0.01 percent by weight, and shows detectable changes, in the sense of an improvement, in particular up to a about one percent by /6 weight.

It is also preferred in particular that an additive be incorporated into the latent-heat storage material, which leads to high viscosity. A conventional thixotropic agent can be used there. Even in the heated state, in which a liquefaction of the latent-heat storage material takes place, a viscosity in the sense of a jelly-like consistency will then still be present. Even when the latent-heat storage body is accidentally cut through, the latent-heat storage material will still either not run out or not run out in any significant amount.

By preference, a latent-heat body formed in this way will also be completely enclosed with a covering, preferably a plastic film. Complete jacketing prevents a running out of perhaps softened or liquefied latent-heat storage material. The envelope can also be produced for example with urea. The plate can be dipped in a melted jacketing material, thus, for example, urea or a plastic, such as for example Nylon (polyamide). Resulting with urea is the advantage of a strong flameproofing effect. The prevention of

discharge is of particular importance when dropping below normal operating parameters. This is especially true when exceeding the normal operating parameters.

The supporting structure will preferably consist of fibrous bodies pressed together from individual fibers. Commercially available fibrous plates can utilized thereby, though relatively soft fiberboards are preferred. Hard fiberboards are able to /7 accept the material for the storage of latent heat to only a small degree. The fibers are themselves preferably absorbent. During the saturation of such a fiberboard with such a paraffin-based material for the storage of latent heat, the fibers become soaked with paraffin; the are "grown". In addition, the capillary spaces between the fibers also become filled with latent-heat storage material. A further development provides for a fleece as the carrier material, for example, a conventional absorbent fleece, like those commercially available for the absorption of oil, acids or other liquids. It can in particular be a fleece consisting completely of polypropylene fibers. The fibers can also be bonded per the meaning of the initially named general teaching, for example, welded. The carrier structure of the fleeces also has importance however aside from that. Of particular advantage is the fact that the mentioned fiber mat, and also the fleece, become consolidated during the saturation with a paraffin-based material for the storage of latent heat. The structure becomes stiffer. For example, such a fiberboard thereby becomes more compression resistant and, for example, resistance to treading. Furthermore, the acoustic properties of latent-heat bodies produced in this way are also improved. Greater absorption of sounds from bodies is also observed. The sound from walking, for example, with the use of such a latent-heat body near the floor, is effectively absorbed. In a further advantageous development, supporting structures are utilized, which permit a saturation with latent-heat storage material in the amount of from two to ten times more than their own weight. In the case of the mentioned fiberboards, for example, a three- to fourfold saturation with latent-heat storage material is carried out. Just the same, saturation is not taken so far that overflow effects result. It is also recommended that a closure /8 of the capillaries be undertaken, for example, by polishing. This closure acts as a supplement to the mentioned jacketing. It is thereby preferred that the closure of the capillaries before the carrier material is saturated with the material for the storage of latent heat.

A further, special teaching of the invention concerns the configuration of the latent-heat storage material based upon paraffin in such a way that there is still flexibility present in the consolidated state. Such a flexible element can be produced in combination with the carrier-material elements, for example, a seat cushion or a bandage. For that purpose it is provided that the latent-heat storage material - on the basis of paraffin - contain a mineral-oil component and/or polymers, rubbers and/or elastomers. The rubbers and/or elastomers lead primarily to greater flexibility. They are contained in the amount of less than 5%. If the polymers are not elastomers, they will not lead to an increase in flexibility and merely prevent, optionally supplementarily, a discharge. By preference, it is a matter of a highly refined mineral oil. For example, a mineral oil that is also commonly called a white oil. In the case of polymers, it is a matter of cross-linked polymers that are produced by copolymerization. The cross-linked polymers form a gel-like structure with the mineral oil by the creation of a three-dimensional network or by their physical cross-linking (nodular structure). These gels possess a high flexibility, with simultaneous stability against the effect of mechanical forces. The paraffin is enclosed within this structure in the liquid state. In the case of a phase change, crystallization, the arising paraffin crystals surround the gel /9
structure, so that a flexible overall mixture results.

In one possible application, a latent-heat storage material, which contains paraffin with a melting temperature of 50°C and a copolymer with a melting temperature of 120°C, is heated to a temperature of 125°C, so that first of all a uniform mixing through of both components is achieved, and the thinly fluid can be absorbed to the point of complete saturation by the carrier material as a result of the capillary forces active in the same. The arising paraffin crystals are surrounded by the copolymer during subsequent cooling. In the case of a for example conceivable upper working temperature of the latent-heat body of 80°C, only the paraffin part, but not however the copolymer, will be liquefied. It is achieved, advantageously, that the paraffin will be unable to exit the copolymer and remain with it in the carrier material. For the invention it is essential that it be possible to achieve the desired capacity to retain paraffin in the latent-heat body with the use of the above-described carrier material already with a mass share of copolymer in the latent-heat storage material of less than 5%. It can be thereby achieved,

particularly by an intentionally induced cooperation of capillary forces in the recesses in the carrier material and/or by means of crystalline structures in the paraffins influenced by structural additives and/or by thixotropic agents that thicken the latent-heat storage material and/or by the described closure of the capillaries as well as, optionally, a jacketing of the latent-heat body, that the desired capacity to retain paraffin can be produced already with parts by mass of the copolymer clearly lower than 5%. One /10
advantage of the invention thereby is the fact that, with a decreasing mass share of copolymers, the mass share of paraffins in the total mass of the latent-heat storage material increases and thus that a higher capacity with regard to heat can be achieved with the total mass unchanged.

A desired structural strength also results, within the framework of flexibility, together with the carrier material described in detail above. But it is also thereby possible to employ still other carrier materials than that described above, for example, foamed materials with open pores. As for the polymers, use is made for example of styrene-butadiene-styrene (SBS), styrene-isoprene-styrene (SIS) or styrene-ethylene/butylene-styrene (S-EB-S). In the case of the styrene-ethylene/butylene-styrene block copolymer, recourse is had to what is known under the trade name "KRATON G", offered by Shell Chemicals. Moreover, further known Kraton variants can also however be used. This block copolymer is particularly suitable as a thickener for increasing viscosity or as an agent for inducing flexibility to increase elasticity. Kraton G is a thermoplastic substance, and several types of copolymers of the Kraton-G series exist, which differ with regard to their structural characteristics. To be distinguished thereby are, in particular, the block and graft block copolymers whose molecular weight varies and which exhibit a different ratio of styrene and elastomer parts. Of the known Kraton G types, use can be made preferably of those types known as G 1650, G 1651 and G 1654.

Furthermore, copolymers such as for example HDPE (high- /11
density polyethylene), PP (polypropylene) or also HDPP (high-density polypropylene) can also be used.

An object of the invention is also a latent-heat storage material based upon paraffin, which exhibits an additive in one of the embodiments described above. Both the latent-heat body as well

as the latent-heat storage material can also exhibit an additive in combination, which produces the hollow structures mentioned above.

The paraffin-based material according to the invention for the storage of latent heat can also be used moreover without any carrier material, i.e. without a supporting matrix. The copolymer share is always less than 5% for reasons having to do with melting/storage capacity and function. The gel formed is filled into container envelopes such as, for example, film bags.

It is essential that the mentioned additive consisting of mineral oils and polymers, on the one hand, be homogeneously distributed in the paraffin or the paraffin homogeneously permeated by this additive and, on the other, that no chemical reaction take place between the additive and the paraffin. It is of particular importance, furthermore, that the selection be made in such a way that practically no differences in density will exist between the additive and the paraffin, so that there will also be no possibility for physical unmixing to take place thereby.

As initially explained, the possibility does exist, in conjunction with one or more of the characteristics described above, for the latent-heat body according to the invention to contain a plurality of latent-heat partial bodies. In the case of /12
a latent-heat partial body, per the meaning of the invention, it is a matter of a coherent and defined part, or component, of the latent-heat body according to the invention, which can combine within itself all the physical, chemical or structural characteristics of the latent-heat body or even any desired selection from the same. By preference, a partial body for the storage of latent heat will contain part of the carrier material and the latent-heat storage material taken up in the capillary-like recesses in this carrier material. The carrier-material part in question can exhibit any of the features of a carrier material explained thus far. In a preferred embodiment, the latent-heat body contains a relatively large number of latent-heat partial bodies, the number being determined by its size and shape, which can be arranged adjacent to one another in regular and/or irregular order. In this way it is possible to produce latent-heat bodies with nearly any size and shape at low cost, because the latent-heat partial bodies can be manufactured industrially, in large numbers, independently of the form of the latent-heat body desired. In a preferred embodiment of a latent-heat body formed from several

latent-heat partial bodies, those parts of the carrier enclosed within the latent-heat partial bodies are also adjacent to one another. These must clearly be distinguished from the carrier-material elements, from which the carrier material, as explained above, is assembled for example with adhesives. The carrier-material elements then form coherent structures, via the enclosure of capillary-like recesses, inside individual carrier-material parts. A cohesion can also however exist between neighboring latent-heat partial bodies, for example, if there is a mutually interlocking engagement of adjacent carrier-material parts in the respectively neighboring coherent structures. Additional coherence between latent-heat partial bodies is possible, when a bonding of /13 the latent-heat storage material of latent-heat partial bodies results.

By preference, the volume ratio of latent-heat bodies to latent-heat partial bodies exhibits a value of at least 10, though still lower or significantly higher volume ratios can in any case be appropriate. An individual latent-heat body can moreover contain latent-heat partial bodies having different dimensions or different shapes. Furthermore, there is also the possibility for individual latent-heat bodies to exhibit an elongated shape and to be formed, at least in the broadest sense, into strips. Alternatively, a latent-heat partial body can also possess a flake-like form. In addition to that, latent-heat partial bodies can also be produced in the form of spheres, ellipsoids, parallelepipeds, cubes, pyramids, cylinders and the like. The choice of the number, the sizes and the shapes of the latent-heat partial bodies of a latent-heat body can be thereby oriented on the size and shape of the desired latent-heat body as well as the demands imposed on it with regard to stiffness or deformability. In a further preferred embodiment of the latent-heat partial body, the latter will exhibit a covering, for example, one consisting of a film material, particularly of an aluminum foil or of a polypropylene film. A film thereby offers the advantage of easy deformability, so that neighboring latent-heat partial bodies can lie close together and cavities between the latent-heat partial bodies largely avoided. Alternatively, or in conjunction with /14 the above, there is also the possibility of providing a plurality of neighboring latent-heat partial bodies with a common outer wrapper, for which it is likewise possible to employ one of the preceding foils. There is furthermore the possibility for the shared outer wrapper to exhibit a wall that is comparatively firm

and more difficult to deform, i.e. in comparison with the latent-heat bodies or latent-heat partial bodies. If such a firm wall is formed as a hollow body, its interior space, even when the shared outer jacket has a complicated geometric shape, can be nearly completely filled with latent-heat partial bodies with respectively any required size, shape or number. The latent-heat partial bodies can be thereby subjected to pressure to prevent the appearance of relatively large hollow spaces inside the firm common wrapper, so that sealing will be achieved at least on an area-by-area basis. In the case of such compacted latent-heat partial bodies, the portion of the volume occupied by hollow spaces between the latent-heat partial bodies will amount to, for example, less than 1% of the total volume of the latent-heat body. The jacketing of the individual latent-heat partial bodies and/or the common wrapper of the latent-heat partial bodies of a latent-heat body are preferably formed in such a way that they are impermeable to the latent-heat storage material.

In an alternative, advantageous embodiment of a latent-heat body, the latter contains a plurality of latent-heat partial bodies that are enclosed by an envelope permeable to a heat carrier, which are preferably positioned at a distance from one another. By locating the latent-heat partial bodies at a distance from one another, hollow spaces are formed between them, which are suitable as pathways for the heat-carrying medium. Provision is made, in /15
particular, for a heat-carrying medium from an external environment to enter the interior of the latent-heat body through its outer jacket, flow through the hollow spaces formed there between the latent-heat partial bodies and then exit the latent-heat body again through the common wrapper of the same, which is permeable to the medium. A latent-heat body with internal flow in this way is distinguished by a particularly rapid transfer of heat from or to a heat-carrying medium. The shared cover of the latent-heat partial body can for example have the form of a lattice or grid, i.e. both easily deformable as well as rigid structures are envisioned. The inlet and outlet openings of the shared outer wrapper of the latent-heat partial bodies contained in the latent-heat body are expediently dimensioned in such a way that a largely unhindered entry and exit of the heat-carrying medium into or out of the latent-heat body is enabled, and that furthermore no latent-heat partial body will be able to pass through unhindered. The volume ratio between the latent-heat partial bodies and the hollow spaces located between them inside the jacket can lie within a wide range

and thereby clearly exceed or drop below the value of one. If a liquid is utilized as the heat-carrying medium, the latent-heat partial bodies can be adjusted with regard to their mass density in such a way that they can be kept suspended in the heat- carrying medium. In this way, the hollow spaces formed are maintained, though a further acceleration of heat exchange can be achieved with the latent-heat partial bodies by their flow-determined circulation. Suitable as a fluid heat-carrying medium are, for example, water or oils and also, in addition to those, other /16 liquids. With the use of a gaseous heat-carrying medium, for example, air, a settling of the latent-heat partial bodies contained in the common wrapper can also be counteracted by an intentionally induced flow that leads to a continuous suspension or circulation of the latent-heat partial bodies. This can be favored by a special configuration of the latent-heat partial bodies, in which the surface is respectively large relative to the weight of a given latent-heat partial body. Conceived is for example a flake-like configuration of the latent-heat partial bodies. Furthermore, the latent-heat partial bodies can exhibit one or several of those characteristics named.

A latent-heat body formed as indicated above can, as already indicated, be built into a heater for floors as a floor element.

The invention also however concerns still further applications of such latent-heat bodies.

A first application consists of a heat exchanger in sheet form, which exhibits latent-heat bodies as sheets. The sheet elements can then be exposed to medium on both sides. For example, heat exchangers, like those known from thermal power plants, can also be fitted. In particular, such a sheet element can also have a spiral shape. Spacing elements are arranged between the layers to produce and support the spiral configuration, though this is also true for flat sheet elements. These are given a lattice-like structure, so that pathways for flow remain open. /17

In a further embodiment form, it is preferred for such a sheet element to be produced as a facade element for house construction. It is thereby particularly advantageous for the facade element to be arranged at a distance from the house wall. The chimney effect then arising between the house wall and the facade element, which is thereby in the form of a latent-heat storage element, can thus

produce a cooling effect as a result, in addition to the storage of heat in the latent-heat body. Furthermore, the thermal behavior over time is also improved. For example, after sundown, the latent-heat body will continue to radiate heat for a long time, while the temperature at the house wall remains the same. At the same time, such a latent-heat body represents an element with relatively high heat damming. Advantageous is also the insensitivity of such a facade element to weather. A water-repellent finish is provided precisely by the saturation with paraffin.

In a further embodiment, a capillary-interrupting grid structure, made for example from plastic, can be arranged in such a latent-heat body, in addition to the carrier structure already described, in the case of all those applications described above. The required equilibrium of capillary forces and gravity, with a vertical positioning of the latent-heat body, is made possible at all times in the filled fiber structure. To permit a diffusion of water vapor, corresponding overflow openings, such as slots, holes and the like, are provided in the latent-heat bodies. Of particular importance there is the fact that the heat-conduction value of this grid structure corresponds approximately to that of /18
the latent-heat storage material. Ordinary metallic structures must therefore be rejected, because the value for thermal conductivity is too high.

As for the configuration of a floor-heater with such latent-heat bodies, it is also proposed that latent-heat bodies with latent-heat storage materials that differ with regard to melting temperature or phase-change temperature are arranged one over the other. In that case, the latent-heat body, directly exposed to a heating element such as a resistance-heating wire, is suitably equipped with latent-heat storage material having the highest phase-change temperature, whereas the latent-heating body with the relatively lowest phase-change temperature is arranged near the surface of the floor. Such a floor heater can be advantageously configured as a nighttime-storage heater, precisely because it is possible to take advantage of the time shift, without the need to take the excessive temperatures known from other nighttime-storage heaters into the bargain.

The invention concerns, furthermore, a method for the manufacture of a latent-heat body with paraffin-based material for

the storage of latent heat absorbed in carrier material exhibiting recesses. According to the invention, it is taken into account that the latent-heat storage material is liquefied and the latter concentrated by the self-acting suction of capillary-like recesses in the carrier material. The liquefaction of the latent-heat storage material can be thereby achieved by the application of heat. The purpose of liquefaction is the achievement of good flowing capability on the part of the latent-heat storage material, i.e., the achievement of low viscosity and a homogeneous /19 consistency without in the form of relative large solid bodies. Good flowing capability creates an essential prerequisite for the penetration of the latent-heat storage material into the recesses under the influence of the self-acting suction of the capillary-like recesses of the carrier material, when it is brought into contact with the same, for example, by saturation in liquefied latent-heat storage material. The conveyance of the latent-heat storage material to capillary-like recesses in the carrier material with self-acting suction can be effected by dipping the carrier material into liquefied latent-heat storage material. Process parameters that influence the automatic uptake of the latent-heat storage material in the carrier material can be influenced to favor the uptake before and/or during immersion. For example, thermal energy can be continuously applied to the latent-heat storage material to promote liquefaction. Furthermore, the liquefied latent-heat storage material can be exposed to pressure, the self-acting uptake of the latent-heat storage material in the capillary-like recesses of the carrier material being favored as a result.

The force of the self-acting of the recesses of the carrier material upon liquids is based upon the capillary-like structure of the recesses, already explained above. The self-acting suctional effect of the capillary-like recesses with regard to liquefied latent-heat storage material and their effort to retain the same becomes the stronger, the smaller the diameter selected for the capillaries or the internal radii of the capillaries, the higher the surface tension selected or set for the latent-heat storage material relative to air and the greater the wettability of the /20 chosen storage material by latent-heat storage material. In the case of the method according to the invention for the production of a material for the storage of latent heat, it is possible to proceed from these relationships to the setting of a desired, particularly a maximal possible self-acting suctional, effect of the recesses upon the latent-heat storage material in such a way

that a material with the highest possible surface tension will be selected, and that the individual carrier-material elements will preferably exhibit internal capillaries with preferably a low radius of curvature and/or external shapes with a low radius of curvature, and particularly also sharp corners or edges. By preference, the carrier material is assembled from individual carrier-material elements, for example, by cementing, capillary-like recesses being formed in each case between the carrier-material elements. During the assembly of the carrier-material elements there is also the possibility of exerting an influence upon the self-acting suction by producing preferably narrow, particularly also fissure-like, capillaries to produce an increase. Furthermore, the invented process can be applied to the manufacture of a latent-heat body on carrier material and latent-heat storage material with all of those characteristics described thus far or with combinations of selected characteristics.

In the case of an advantageous variant of the method according to the invention, the carrier material, saturated with latent-heat storage material, is separated into a plurality of latent-heat partial bodies, in which case it is possible for the separation to take place by sawing and/or cutting and/or tearing or even according to other known methods of separation. Also existing is for example the possibility of saturating a fiber sheet /21 consisting of cellulose fibers, selected as a carrier material, with previously liquefied paraffin-based latent-heat storage material and then sawing the saturated carrier material into elongated latent-heat partial bodies, particularly in the form of strips. As a further variant, a fiber fleece, selected as a carrier material, can for example be torn after saturation with latent-heat storage material into a desired number of comparatively smaller latent-heat partial bodies that can exhibit a flake-like form but also a one differing from the latter. In a further development of the production process according to the invention, the latent-heat storage body and/or the latent-heat partial bodies can be pressed for compaction or to produce a desired form. There is also the possibility of providing the latent-heat body and/or latent-heat partial bodies with a covering that can consist of a film, particularly one consisting of aluminum foil or polypropylene film. It is thereby preferred that the latent-heat body or latent-heat partial body be completely enclosed by a wrapper that is impermeable to latent-heat storage material and sealed inside, for example by welding, in such a way that no latent-heat storage

material can exit the envelope. In a further development of the process according to the invention, the latent-heat partial bodies can also be provided with a covering that encloses them all together, which can likewise possess those properties cited above. In particular, an easily deformable common envelope can be provided, which, in conjunction with a plurality of smaller latent-heat partial bodies contained therein, can lead to a desired deformability of the latent-heat body. Alternatively, a common envelope can be used, which exhibits greater stiffness or a /22 lesser degree of deformability than the saturated carrier material. Such a covering, which can also be a varied housing for everyday articles for practical use, can also, according to one variant of the invented process, be filled with a desired number of latent-heat partial bodies, it being then possible for a compression of the latent-heat partial bodies inside the common envelope to take place in a further processing step. With the process according to the invention, a nearly complete filling of any hollow spaces in practical-use articles with saturated carrier material can be effected in a simple, time-saving and economical manner.

In a further development of a latent-heat body according to the invention, provision is made, in conjunction with one or more of the previously mentioned features, for at least one microwave-active substance to be contained in the latent-heat body. In the case of a microwave-active substance per the meaning of the invention it is a matter of such a material that undergoes an internal heating under the influence or radiation by so-called microwaves, this heating being based upon an excitation movement of its molecules by the energy-rich electromagnetic radiation. The microwaves link up with the wavelength range of infrared radiation to produce longer wavelengths. To that extent, the starting point must be an approximate wavelength of 1.4×10^{-3} m, in which case an optimization of the internal heating can be achieved within the range of technical interest by an adaptation of the selected wavelength to the molecular structure of the microwave-active substance to be employed. A latent-heat body containing such a microwave-active substance thus exhibits the advantage over heat- /23 transfer by shortwave radiation that significantly shorter time spans are needed for the input of a certain quantity of energy, correspondingly more rapid heating being possible. In particular, it is intended that the microwave-active substance be uniformly distributed within the latent-heat body, so that a correspondingly uniform heating can also be observed. A uniform distribution does

not thereby also necessarily presume a homogeneous distribution per the meaning of the invention, because a uniform heating of the latent-heat body adequate for technical applications can be achieved on the basis of heat-conduction phenomena even when the microwave-active substance is present in distribution over the latent-heat body in clumps that lie sufficiently close to one another. For that, there is for example the possibility for the carrier-material elements to contain the microwave-active substance and for the microwave-active substance to be contained in capillary-like recesses between carrier-material elements composed for example by cementing to form a carrier material or in capillary-like recesses inside the carrier elements, or for the microwave-active substance to be contained in recesses formed between several latent-heat partial bodies, in which case a combination of these proposed distributions is also conceivable. A uniform distribution of the microwave-active substance within the latent-heat body is also supported by the fact that the microwave-active substance is contained there in a powder- and/or granulate- and/or fiber-like form. If an uptake of the microwave-active substance into those recesses formed between the latent-heat partial bodies is to take place, even larger coherent structures of the microwave-active substance can be ultimately advantageous, whose dimensions can also be of a size comparable to that of the /24 latent-heat body. Conceived is, in particular, a network or lattice consisting of a microwave-active substance provided in a form that is integrated into the latent-heat body. Alternatively, or in combination with the above-described distribution forms of the microwave-active substance as a solid material, it can be expedient for the microwave-active substance to be a liquid at least at the working temperature of the latent-heat body, in which case all media capable of flowing enter into consideration for this purpose. With regard to the selection of the material for the microwave-active substance, consideration can be given to essentially all substances that undergo interior heating under the effect of microwaves. By preference, it is a matter of a substance found within the group of materials including glasses, plastics. mineral substances and metals, particularly aluminum, carbon and ceramic. it is also possible for several different microwave-active substances to be employed together in a latent-heat body. The result thus achieved is that a more rapid transfer of heat to the latent-heat body will be possible at more than one wavelength or within a certain wavelength range. Named as preferred embodiment forms of the microwave-active substance are granulate-

like glass bodies, granulate-like plastics, mineral fibers, ceramic fibers, charcoal dust, metal, especially powdered aluminum, and wire formed from a metal that can be processed further into a grid-like lattice.

To produce a latent-heat body that can be heated by
microwaves, a microwave-active substance must be added to the
latent-heat body or a component of the same in one processing /25
step, the goal of this step being preferably a uniform distribution
of the microwave-active substance in the latent-heat body. It is
also possible to proceed in such a way that the microwave-active
substance is added to the carrier-material elements during
manufacture. In particular, the carrier-material elements can also
themselves be produced directly from the microwave-active
substance. Alternatively, or in combination with the above, it is
also possible for the microwave-active substance, during the
production of carrier-material elements, especially by cementing,
to be embedded continuously or discontinuously in the capillary-
like recesses thereby formed. This can take place for example in
the case of a carrier material with a layered structure, after the
completion of a respective layer by cementing carrier-material
elements, by sprinkling a microwave-active substance in the form of
a dust or powder onto the surface of the layer and then, after the
removal of excess dust or powder, by providing an additional layer
over the same, as many repetitions of this process as desired being
possible. In the case of a latent-heat body containing multiple
latent-heat partial bodies, the microwave-active substance can also
moreover be embedded in the recesses formed between latent-heat
partial bodies. The microwave-active substance can be processed
thereby both as powder as well as granulate or fibers and,
furthermore, also as wire or a grid-like network. The procedure is
thereby preferably such that a layer of latent-heat partial bodies
is first of all arranged in a common wrapper, that microwave-active
substance is then deposited in the interstices and that a further
layer of latent-heat partial bodies is subsequently applied, in /26
which case it is possible to repeat these steps in the process as
many times as desired. In the case of a further variant of the
production process according to the invention, the microwave-active
substance is added to the latent-heat storage material before the
latent-heat storage material is introduced into the capillary-like
recesses of the carrier material. It is preferable that care be
taken thereby to ensure that a uniform distribution of the
microwave-active substance within the latent-heat storage material

is achieved, so that the microwave-active substance will also be sucked in uniform distribution into the capillary-like recesses of the carrier material and be present there uniformly distributed with the latent-heat storage material. Alternatively, or in combination with the thus far described processing of the microwave-active substance in a solid aggregate state, there is also the possibility of adding the microwave-active substance to the latent-heat body in liquid form, in which case essentially all the above-described techniques for the addition of the same enter into consideration.

If the microwave-active substance cannot be utilized in its raw state directly for the production of a latent-heat storage body, the invented process for the manufacture of a latent-heat body to be heated by microwaves will include additional processing steps, in which a desired condition of the microwave-active substance can be achieved. Among these are, for example, a processing of the microwave-active substance as needed in a given case to produce a powder, a granulate or fibers, preferably by mechanical methods of separation such as, for example, sawing, cutting, grinding and tearing. If an application of the /27 microwave-active substance in a wire-like form or as a grid-like lattice is contemplated, the method according to the invention for the manufacture of a latent-heat body that can be heated by microwaves will also include processing steps for the processing of the microwave-active substance into structures according to need. Numbered among these, in particular, are the wire-drawing of suitable materials and the further processing of the wires obtained to form a grid-like lattice.

The invention is explained below with the aid of the attached drawing, which however represents merely example embodiments. Appearing there are:

Fig. 1 a cross section through a latent-heat body on the basis of a fiber sheet;

Fog. 2 a latent-heat storage element with latent-heat storage bodies arranged inside;

Fig. 3 a facade with latent-heat storage bodies;

Fig. 4 a structure relating to a floor heater;

Fig. 5 a structure according to Fig. 4, in an alternative embodiment;

Fig. 6 a schematic view of a supporting structure for incorporation into a fiber sheet;

Fig. 7 a vertical section through a mobile body for heat storage, with latent-heat bodies;

Fig. 8 a horizontal section through a shipping container for medical purposes, with latent-heat bodies; /28

Fig. 9 a vertical section through a dog-food container with latent-heat bodies;

Fig. 10 a vertical section through a container for cat food, with latent-heat bodies;

Fig. 11a a top view f a storage element for air/water heat exchangers with latent-heat bodies welded in;

Fig. 11b a side view of the storage element according to Fig. 11a, in the arrangement when folded together;

Fig. 12a a top view of a heating/cooling cover with welded-in latent-heat bodies that have been sewn in;

Fig. 12b a side view of the heating/cooling cover according to Fig. 12a, when rolled up;

Fig. 13 a mitten with integrated latent-heat bodies welded in;

Fig. 14 a shoe sole in a design with a foil welded in as a latent-heat body;

Fig. 15 a vest with integrated latent-heat bodies welded into foil;

Fig. 16a a top view of a latent-heat body as a storage element for building construction, in an a version as a saturated lattice structure; /29

Fig. 16b a side view of the storage element according to Fig. 16a,

in an arrangement between two wall elements;

Fig. 17 a solar evaporator with latent-heat body for a composter;

Fig. 18 a section through a beverage cooler with latent-heat storage material, at the beginning of the cooling process;

Fig. 19 a beverage cooler according to Fig. 18, with an embedded beverage container, during the cooling process;

Fig. 20 a vertical section through a dog-food container with a latent-heat body that contains a plurality of latent-heat body parts

Represented and described, first of all with reference to Fig. 1, is a latent-heat body **1** that consists of a fiber sheet **2**, saturated with a paraffin latent-heat storage material, and a covering **3**. The fiber sheet **2** is a soft-fiber sheet filled with a paraffin latent-heat storage material. The filling is in the form of an impregnation.

Specifically, it is a matter of a fiber sheet consisting of poplar fibers, which is comparatively soft in the unsaturated condition. But other cellulose fibers can also be used. In the unsaturated state, the fiber plate has a density of approximately 200 kg/m^3. Preferred are fiberboards in the density range of 150 - 300 kg/m^3 in the unsaturated condition. In the saturated state, the fiber sheet has a density of about 700 kg/m^3. Preferred here is a range of approximately 550 - 800 kg/m^3. The volume share of paraffin in the structural matrix amounts to approximately 50%, the mass share of the paraffin or latent-heat storage material in the matrix to about 68%. /30

The fiber sheet can also be provided with a flameproofing additive. Surprising is the fact that practically no dimensional changes in the fiber sheet can be detected relative to the solid or liquefied state of the latent-heat storage material. This is true in particular, when the latent-heat storage material is provided with an additive, which, as indicated in detail above, leads to the formation of inherent hollow structures. Such a fiber sheet can also be employed as air or water heat-transfer sheets as well as a wall storage sheet.

As an alternative to the above, a saturated fiber sheet based on fleece is also proposed, which is not shown in a detailed drawing. Utilized is preferably a highly porous fleece, also one produced for example from polypropylene fibers. Such a fleece can exhibit a density of about 100 kg/m^3 in the unsaturated state, with a preferred range of approximately 70 - 150 kg/m^3. Saturated with paraffin, such a fleece-based sheet has a weight of about 700 kg/m^3, with a range of about 600 - 800 kg/m^3. The share of latent-heat storage material in the matrix amounts in this case to about 65%, the mass share corresponding to about 85%. Such a fiber sheet can also be produced in transparent or opaque form. It is /31 essential that such a sheet is flexible even in the consolidated condition of the latent-heat storage material. It can also be employed for example, in addition to the above-mentioned application cases, as a mat for greenhouses.

Instead of the described fiber sheets, consideration can also be given to a fleece or a textile, possibly in combination with a fiber sheet, as a saturation body. In particular, cotton fabric or cotton knits are important in this regard.

The covering **3** consists of an aluminum foil. But a polypropylene film can also be used.

Seen in Fig. 2 is a first application example. It is a matter here of a latent-heat body **4**, in which a plurality latent-heat bodies **1** are arranged vertically. It is possible, for example, for air to flow through the latent-heat body **4**. But water can also flow through in the same way. Heat can be thereby stored in the latent-heat bodies **1** in the known manner and, as a result, release it again, when a relatively colder medium flows through it.

In the case of the example embodiment in Fig. 3, the latent-heat bodies **1** are configured as facade elements. Special structures can also formed on the outer side **5**. For example, slabs of slate or the like can also be installed in front of it. Essential, aside from the arrangement as a facade element, is the fact that a gap S remains between the masonry wall **6** and /32 the latent-heat bodies **1**. The gap **S**, with a lower and an upper opening, can be used to produce a chimney effect. As a result, the climatic conditions and particularly the adaptation to the day-night cycle can be significantly improved. A phase-shifted cooling or heating effect is produced. Because the heating of the latent-

heat storage material first occurs only at the phase-change temperature, a certain retaining effect then taking place, more time is needed for the heat to "break through". Inversely then, when heating by the sun falls off, overheating builds up quickly and, on the other hand, a relatively long heating effect persists at about the same level when the phase-change temperature is reached.

Seen in Fig. 4 is the concrete covering in a building, labeled with 7, which is produced as the false floor between floors. On the concrete covering **7**, an insulating layer **8** is provided as a heat barrier, for example, one consisting of a polyurethane foam. Formed over the insulating layer **8**, in the case of air heating, are air channels **9** that can serve for the delivery of heat via warm air. Furthermore, over the air channels **9**, a first layer of a latent-heat body 1 is installed in one of the arrangements such as those described here. Arranged over that is a further heating register **10** that can consist for example of water pipes or an electrical heating system. Arranged over that, in one of the arrangements described here, is a further layer formed by a latent-heat body **1**. Arranged over that, finally, is a layer of floor finish **11**, and the structure is completed in the upward direction by a floor covering **12**, for example, carpeting or tiles.

The configuration of the floor structure in Fig. 5 corresponds to that in Fig. 4, but no air channels **9** are formed in this case. The first layer of latent-heat bodies **1** is applied directly over the heat insulation **8**. Then comes the heating register **10** and over it the second layer consisting of latent-heat bodies **1**. /33

Illustrated in Fig. 6 is a supporting structure **13**, produced as a grating or grid structure. The supporting structure **13** consists preferably of a plastic and exhibits a value for heat conductivity similar to that of the heat-storage material.

Fig. 7 shows a mobile heat-storage body **14**, which exhibits an external housing **15** and is able to roll on casters **16**. Present inside the housing is a heating element **17** that can be formed by wires that transmit flow, with latent-heat bodies **18** on both sides. When the heating element **17** is switched on, the heat given off will preferably be taken up by the storage elements **18**, with surfaces parallel to the same, which will continue to deliver heat uniformly

to the ambient environment over a comparatively long time interval, via the housing **15**, even after the heating element **17** has been switched off.

Seen in Fig. 8, in horizontal section, is a shipping container to be utilized for medical purposes, for example, for the storage or shipment of preserved blood or organs **20**. The container consists of a stable external housing **21** and an inner container **22** contained in the same with turning clearance, which possesses dimensions smaller than those of the outer container. The inner side of the outer container is thereby lined with a continuous /34 layer of insulating material **23** that can be a commercial insulating material, for example, Styropor. The space remaining between the insulating layer **23** and the inner container **22** serves to accommodate latent-heat bodies **24**, **25**, which in the case of the example shown can be a matter of saturated wood-fiber elements. But there is likewise the possibility here of using a saturated fleece or other latent-heat body inserts described in the application. In the embodiment example shown, the latent-heat bodies **24**, **25** are arranged in pairs, surface-parallel, so that they will completely fill the space between the inner container **22** and insulating layer **23**. Thereby employed are several pairs of latent-heat bodies **24**, **25**, the pairs being mutually offset. Other arrangements that appear to be efficient can also be used as an alternative to the arrangement shown. The latent-heat bodies **24** and **25** can differ with regard to the phase-change temperatures of their respective latent-heat storage materials, so that an optimal storage effect can be achieved, as a function of the ambient temperature of the outer container **21** and the temperature desired in the inner container **22**, by the use of a multistage storage element with selected phase-change temperatures. The shipping container **19** exhibits, furthermore, a bottom (not shown) and a lid that is able to pivot on the same, for example, on hinges, a composite structure consisting of an insulating layer **23** and latent-heat bodies **24**, **25** being likewise provided in the bottom and lid areas.

Fig. 9 describes, in a vertical section, dog-food container **26** that exhibits an external housing **27** with a bowl **28** in its upper side for the dog food **29**. The inner space of the food container, both beneath and beside the bowl, serves to receive a latent- /35 heat body **30**, which serves in the preferred application as a cooling element and stands in a heat-exchange relationship with the

dog food via the wall area of the bowl **28** that is designed for good heat-conductivity.

The cat-food container **31**, shown in a vertical section in Fig. 10, consists of a lower housing **32**, on which an upper housing **33** is mounted and thereby centered by means of a centering system **34**. The centering system **34** can thereby consist of pin- or knob-like projections in the upper part **33** and recesses **34** in the lower part **32**, which are adapted to the shape and position of the same, though they can also be formed in a different manner. The upper part **33** exhibits a bowl **35** to receive the cat food **36**, the bottom area **37** of the bowl **35** being produced preferably with a thin wall from a material with good heat conductivity. The lower housing **32** exhibits, in its interior, a heat barrier **38** that is in turn provided on its upper side with a cavity **39** to receive a latent-heat body **40**. Suitable in this conjunction for use as a latent-heat body are any of those embodiment forms described in the application. Provision is made, according to the illustration, for the lower side of the upper housing to be in surface-parallel contact with the patent-heat bodies **40** in the zone of the bowl **35**, when the upper housing **33** is positioned on the lower housing **33**, so a good transfer of heat will take place between the animal food and the latent-heat body. The food containers described with reference to Fig. 9, 10 can also additionally employed to contain other /36 types of foods not mentioned in detail.

Fig. 11a presents a top view of a storage element for air/water heat exchangers **41**, formed in the example from four latent-heat bodies **42** welded into a weldable film **41'**. As an alternative to the row-like arrangement of four latent-heat bodies **41** shown, latent-heat bodies can also be produced in a different type of storage element with different numbers of elements and arrangements. For the application case shown, it is possible to any of the embodiment forms described in the application. Provision is made in the embodiment example shown, provision is made for the latent-heat bodies **42** to be laid pieces of film **41'**, laid one upon the other, and completely enclosed on all sides with welded seams **43**, **43'**. It is furthermore proposed for the welded seams **43'** to be formed likewise between neighboring latent-heat bodies **41**, as preferred bending or folding zones, so that the storage element **41** can be employed for various applications in different forms for use, without thereby damaging the latent-heat bodies **42**.

Fig. 11b shows a side view of the storage element for air/water heat exchangers according to Fig. 11a, in a possible folded position.

Fig. 12a shows a top view of a heating/cooling cover **44** when spread out. As apparent from Fig. 12b, presenting a side view of the cover when it is rolled up, the cover **44** consists of two fabric sheets **45**, **45'** arranged parallel to one another, between which a number of latent-heat bodies **46**, welded into protective /37 envelopes that are not shown in detail, are sewn.

Corresponding to the embodiment example in Figs. 12a, 12b, the fabric layers **45**, **45'** are bonded together by edge-side seams **47** and connecting seams **48** between the latent-heat bodies **46**, so that an inner coherence results without the danger of the latent-heat bodies **46** slipping. The illustrated heat/cooling blanket **44** can be employed for example as a baby blanket or as a crash blanket. Flexible latent-heat bodies **46** are therefore preferred for use, in which case the carrier material can be a fleece. Whereas the top view in Fig. 12a shows only a portion of a heating/cooling blanket **44** that has been spread out, Fig. 12b presents, in a side view, the arrangement of a complete blanket that has been rolled up. Deviating from the example embodiment shown, configurations with a different form, number and arrangement of latent-heat bodies **46** is conceivable.

Fig. 13 shows, as a further application example, a top view of a mitten **49**, with latent-heat bodies **50**, **50'** sewn between its inner and outer fabric layers that are not shown in detail. Flexible latent-heat bodies, whose carrier material can be a fleece, are likewise employed by preference for this example application.

Fig. 14 shows an insole **51** for a shoe. It is accordingly proposed that a latent-heat body **52**, preferably with flexible properties, be welded into a film **53**, in which case additional sole layers, not shown, can be attached to the upper and/or lower side of the sole **52**. Structured layers consisting of materials such as, for example, foam or rubber, can be used by preference on the /38 sole underside to prevent the insole **51** from slipping in the shoe. Textiles, for example, even layers of wadded fabric, can be provided on the upper side of the insole **51** to provide an additional increase in comfort.

Fig. 15 presents a front view of a vest **54** with latent-heat bodies **55**, **56** and **57** sewn between the inner and outer fabric layers that are not distinguished in the drawing. To obtain the greatest possible degree of comfort for the wearer, flexible latent-heat bodies are utilized in that case, which are individually welded into a covering. Suitable as a covering are for example films and, in this case, particularly aluminum foil or polypropylene films.

Fig. 16a is a view of a latent-heat body **58** according to the invention, produced as a storage element for use in building construction. As seen in the drawing, the latent-heat body exhibits a lattice-like structure produced from carrier material that can consist of textile materials, flax or other suitable materials with capillary recesses for the latent-heat storage material according to the invention. According to the embodiment example, the carrier material **59** is saturated with latent-heat storage material that is not shown in detail, the saturated lattice structure being permeable to water vapor, which permits a diffusion of water vapor in the walls.

Fig. 16b shows a preferred application of a storage element according to Fig. 16a, with the aid of a sectional view along line XVI-XVI. The storage element **58** is thus arranged in a vertical position, surface parallel, between two spaced wall elements /39
60, **60'**. As an alternative to the embodiment shown, different configurations of the lattice structures are also possible.

Fig. 17 describes, with the aid of a schematic drawing, a preferred application of a latent-heat body **61** according to the invention as a storage element for a solar evaporator **62**. The solar evaporator accordingly exhibits an external housing **63** that is closed at the top cover **64**, for example, a glass plate, which permits the passage of energy-rich radiation, such as for example solar radiation. Arranged in the floor region of the outer container is an insulating layer **65** that can be manufactured from conventional insulating materials, for example, Styropor. It is also possible for the side walls to be likewise equipped with corresponding insulating layers. Water is introduced into the housing through an inlet **66**, while the use of a safety valve, which can - as shown - be a float, prevents overfilling beyond a certain level. Air is preferably blown by means of a fan **70** into that space **69** remaining between the covering **64** and the surface of the water, through an inlet **71**. The air, enriched with water over the

water surface, escapes as a result of the arising excess pressure through a line **72** into a consuming device **73**, which, in the case of the application shown, can be a composter. The energy needed for the evaporation of the water is supplied to the container by means of the energy-rich radiation incoming through the cover **64**. The latent-heat body **61** shown is located beneath the water surface /40 and, in the case of the example illustrated, fastened with conventional attachment elements to the side walls of the housing **63** in a manner that is not shown in detail. As an alternative, the possibility also exists for the latent-heat body **61** to float unattached in the water. For that purpose it is proposed that elements for increasing or decreasing buoyancy be attached to the latent-heat body, which can be used to hold the latent-heat body precisely in suspension in the surrounding water, so that no rising onto the surface or sinking to the container bottom will be possible, and all surfaces of the latent-heat body will participate in the exchange of heat. Weights of any kind can be used as means for reducing buoyancy, conceivable as means for increasing buoyancy are for example air-filled chambers. The arrangement seen in Fig. 17 has the advantage over conventional solar evaporators that the latent-heat body **61** used, with exposure to intensive solar radiation and thus a high heat input, will absorb and store a large portion of that heat not needed for evaporation and release it into the surrounding water during cloudy or nighttime phases when the intensity of incoming radiation is low, so that uniformity of the evaporation output will be achieved. For that application described in Fig. 17, the latent-heat body 61 can be produced from any of the carrier materials and latent-heat storage materials named in the application. Due to the negligible miscibility of the latent-heat storage material with water, the latent-heat body can moreover be utilized, as desired, with or without a covering. If no outer covering is provided for the latent-heat body, the capillaries of the carrier material can be closed on the outer surface by polishing or the like, so that additional protection against an escape of latent-heat storage material into the /41 environment is achieved.

The invention furthermore concerns cushions, underlays, rollers, bandages, strips, belts and inserts, packaging, compresses for the application of heat and/or cold for medical, orthopedic and veterinary purposes, which are equipped with latent-heat bodies according to the invention. Appropriate in this context is for example the use of flexible latent-heat bodies, the carrier

material suitable for the same being, in particular, a fleece, a fiber sheet produced on the basis of a fleece or a flexible fiber sheet produced from a different material. Further preferred applications for the invented latent-heat body relate to belts, inserts for the application of heat and/or cold for purposes having to do with health, particularly for use in athletics, leisure articles and at the workplace.

Also conceivable furthermore, with regard to the shipping container for medical purposes seen in Fig. 8, is the use of latent-heat bodies according to the invention with or without enclosing containers and films for purposes having to do with insulation and/or the storage of heat in additional thermal means for transport or packaging. Thermal containers for commercial and/or domestic use represent a field of possible application for the latent-heat body according to the invention.

Beyond those applications for building purposes already thus far described in the application, still further application possibilities are conceivable in the construction field, such as for example the lining of swimming pools - in this case /42 particularly unheated outdoor pools - to provide uniformity in the temperature of the water, which is also determined by solar radiation, through the course of the day. According to the invention, latent-heat bodies can also be utilized in the construction field as a material for the storage of cold as well as for the storage of heat. Coming first to mind is an application in air-conditioned houses, in which latent-heat bodies can be arranged for example behind wall coverings, but also in the floor and/or ceiling area, to permit a uniform reduction in room temperature even with intermittent operation of the cooling system. The switching frequency of the compressor is advantageously reduced as a result.

In addition to that, latent-heat bodies according to the invention can be employed as latent-heat and/or -cold storage materials for use in vehicles for travel on land, in the air and on water. Thereby conceivable is, for example, is an application in the cargo areas of delivery trucks, aircraft and ships. Thereby conceivable is, for example, is an application in the cargo areas of delivery trucks, aircraft and ships, for example, in the spaces intervening between containers.

The paraffin-based latent-heat storage material absorbed into the capillary-like recesses of a carrier material in the case of those applications described thus far can also be used, in many cases, without a carrier material. The heat-storage thereby retains its heat-storage function and is further characterized by easy and nearly unlimited deformability. As a possible application example, Fig. 18 describes a beverage cooler **74** that produces the cooling of a beverage **76** enclosed in a beverage container **75** at a rate that is accelerated in comparison with that of known /43 cooling systems. The beverage cooler **74** contains, according to the embodiment example shown, a container part **77** that contains a latent-heat storage material **78** in its interior. The surface of the latent-heat storage material **78**, not enclosed by the container part **77**, is covered by a film **79** attached to the edge of the container part **77** in such a way that the latent-heat storage material **78** will be unable to escape from the beverage cooler **74** in the liquefied state. The attachment of the film **79** to the edge of the container part **77** can take place with suitable fastening elements **80**. In Fig. 18, a contoured strip that fits over the edge of the container part **77** is selected as such a fastening element, which extends along the entire length of the edge and is bonded to the film **79** and the container part **77**, for example, by means of continuous layers of adhesive **81**, **82** or a different bonding and sealing means. As an alternative to the fastening element **80** selected as the contoured strip, which performs an optical function in addition to its sealing action, a direct seal can also be provided between the film **79** and the edge of the container part **77**. provision is made, preferably, for the dimensions of the film **79** in the stretched state to exceed the distance between the edges of the container part **77**, so that the film **79** in the initial wavy or folded state, or even overlapping itself, will extend in a more or less irregular manner over the surface of the latent-heat storage material. As an example, the sectional view in Fig. 18 shows in addition an arrangement of the film **79** with folds **83**. In preparation for use, the beverage cooler 74 placed in a cooling device, for example, a refrigerator or a freezer and left there until the latent-heat storage material has undergone a desired cooling. After it has been removed from the cooling device, a /44 beverage container **75**, for example, a beer bottle, is laid or placed on the outer surface of the foil **79**, as this is likewise illustrated in Fig. 18. With the beverage cooler in the essentially horizontal position, the beverage container sinks down into the interior of the container part **77** due to its own weight

and the easy deformability of the film and the latent-heat storage material, thereby coming increasingly into contact with the film adjacent to the latent-heat storage material becoming enclosed by it, in which case, as seen in Fig. 19, the film becomes increasingly stretched in the plane of the container opening.

An arrangement is reached in Fig. 19, in which the beverage container **75** is nearly completely enclosed by the film **79** lying against it and the adjacent latent-heat storage material. The greater portion of the outer surface beverage container **75** is as a result in a condition of direct heat exchange, via the film **79**, with the cooled latent-heat storage material **78**. Due to the resulting possibility of very good heat conduction from the beverage container into the latent-heat storage material, a very rapid cooling of the beverage container and of the beverage it contains is achieved. Once a desired cooling of the beverage container or beverage has been achieved, the beverage container is taken out of the beverage cooler. Then, as a function of the deformability of the film **79** and the material properties, particularly surface tension and viscosity, the latent-heat storage material **78** gradually returns to its original shape.

The above-described beverage cooler **74** can be employed /45 moreover for the cooling of other articles, for example, solid foods. By inverting the principle of operation, it is just as conceivable for the latent-heat storage material to be warmed in a heating device, for example, in an oven, and for it to be used, after its removal from the heating device, to heat articles, for example, containers of solid or liquid foodstuffs. Instead of a film **79** with a surface oversized relative to the container opening as in Figs. 18, 19, there is furthermore the possibility of using a film that possesses an essentially stretched extent even in the unloaded state and permits a body placed on it for cooling or warming to sink into the container interior by its own weight as a result of the easy stretchability of the film.

Also for applications of the latent-heat storage material on the basis of paraffin without carrier material, the latent-heat storage material can contain one or more of those additives thus far described in order to achieve advantageous properties. By preference, additives are thereby used, which produce gel-like properties in the latent-heat storage material. In addition to that, cross-linked polymers produced for example by

copolymerization as well as mineral oil and, if necessary, further additives, can be added to the paraffins.

In a further preferred embodiment, provision is made for the latent-heat storage material **78** inside the beverage cooler **74** to be completely enclosed in a pouch consisting of a film impermeable to latent-heat storage material, that side of the film facing away /46 from the latent-heat storage material lying up against the beverage container and thereby enclosing it in the latent-heat storage material.

Seen in Fig. 20 is a possible application example of a latent-heat body that contains a plurality of latent-heat partial bodies 84. Specifically, it is a matter of a food container **26** with an outer housing **27**, which corresponds to a food container from Fig. 9. It however differs from the latter due to the fact that a plurality of latent-heat partial bodies **84** are utilized instead of a latent-heat body **30** in one piece, in which case that volume filled with latent-heat partial bodies **84** amounts to more than ten times the volume of individual latent-heat partial bodies **84**. In a further comparison with Fig. 9, it is evident in Fig. 20 that latent-heat bodies formed from many smaller latent-heat partial bodies can be easily filled into even undercut housing shapes. In the case of the food container shown in Fig. 20, a compression of the latent-heat partial bodies can also moreover be produced in the zone bordering the bowl 28 by the application of mechanical force, so that a preferred heating or cooling effect will be obtained there.

All the disclosed characteristics are essential to the invention. Hereby included in the disclosure of the present application is also the entirety of the disclosure content of the associated/attached priority documents (copy of the prior application), also for the purpose of incorporating characteristics of these documents into claims of the present application.

C L A I M S /47

1. Latent-heat body (1) with latent-heat storage material based upon paraffin absorbed in a carrier material exhibiting recesses, the carrier material consisting of an organic plastic or natural material, characterized by the fact that the carrier material is assembled from individual carrier-material elements, for example,

by cementing, capillary-like recesses for the latent-heat storage material being formed at any rate between the carrier-material elements.

2. Latent-heat body according to Claim 1 or in particular those that follow, characterized by the fact that the carrier material is a fiber sheet consisting of cellulose fibers.

3. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat body (1) exhibits a covering.

4. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the covering consists of a film material.

5. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the covering consists of an aluminum foil.

6. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the /48
fact that the covering consists of a polypropylene film.

7. Latent-heat body according to the features of the description in Claim 1 or one or more of the preceding claims or in particular those that follow, characterized by the fact that the carrier material is a fleece.

8. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the carrier material is saturated with latent-heat storage material in the amount of approximately from two to ten times its own weight.

9. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat body is arranged as a flat body in a heat exchanger.

10. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat body is arranged as a floor element in a

floor heater.

11. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat body is formed with a spiral shape.

12. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the capillaries are closed on the outer surface of the carrier material by polishing or the like.

13. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the fibers are cemented together. /49

14. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the fiber sheet is a flexible fiber sheet produced under low pressure.

15. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat storage material is finished with a thickening fluid.

16. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the thickening means is a means with a delaying effect.

17. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the latent-heat storage material contains a share of mineral oil and polymers.

18. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the mineral oil is a highly refined mineral oil.

19. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the mineral oil represents an approximately 10-50% share of the latent-heat storage material. /50

20. Latent-heat body according to one or more of the preceding claims or in particular those that follow, characterized by the fact that the mass share of the polymer in the latent-heat storage material amounts to not more than 5%.

21. Mobile-storage heating bodies (14) with latent-heat bodies (18), which exhibit one or more characteristics of Claims 1 to 20, characterized by the fact that the latent-heat bodies (18) stand in a position of heat exchange with the heating element (17) and in further heating exchange with the external housing (15).

22. Shipping container (19) with latent-heat bodies (24, 25), which exhibit one or more characteristics of Claims 1 to 20, characterized by the fact that the latent-heat bodies (24, 25) are arranged between an inner container (22) and an outer housing (21) at a distance from the same and surface-parallel to the walls of the outer housing (21) and those of the inner container (22).

23. Shipping container (19) according to Claim 22 or in particular those that follow, characterized by the fact that the latent-heat bodies (24, 25) contain latent-heat storage materials with differing phase-change temperatures.

24. Food container (26) with a latent-heat body (30), which exhibits one or more of the characteristics of Claims 1 to 20, characterized by the fact that the upper side of an outer housing (27) exhibits a bowl (28) for receiving food (29), especially /51
dog food, and that the heat-conductive wall of the bowl (28), on the surface opposite to that of the food (29), is in a condition of heat exchange with the latent-heat body (30).

25. Food container (31) with a latent-heat body (40), which exhibits one or more of the characteristics of Claims 1 to 20, characterized by the fact that a cavity (39) for the latent-heat body (40) is formed in the lower housing (32) with heat barrier (38), and that an upper housing (33) with a bowl (35) for food (36) is mounted on the upper housing (33), in which case the food (36) stands in a state of heat exchange, through a wall (37) with the capacity to conduct heat, with the latent-heat body (40).

26. Storage element for air/water heat exchangers (41) with latent-heat bodies (42), which exhibit one or more of the characteristics of Claims 1 to 20, characterized by the fact that

the latent-heat bodies are positioned in a neighboring arrangement between the welded-film sheets (41') covering the latent-heat bodies and are completely enclosed between the welded-film sheets (41') by means of welded seams (43, 43'), in which case welded seams (43') running between neighboring latent-heat bodies (42) are configured as preferred deformation zones.

27. Warming/cooling cover (44) with latent-heat bodies (46), which exhibit one or more of the characteristics according to Claims 1 to 20, characterized by the fact that the latent-heat bodies are arranged adjacent to one another between fabric sheets (45, 45') arranged surface-parallel to one another and held between the /52
fabric sheets (45, 45') by means of seams (47, 48).

28. Mitten (49) with latent-heat bodies (50, 50'), which exhibit one or more of the characteristics according to Claims 1 to 20, characterized by the fact that the latent-heat bodies are sewn between inner and outer fabric layers of the glove.

29. Insole (51) for shoes with latent-heat bodies (52), which exhibit one or more of the characteristics according to Claims 1 to 20, characterized by the fact that the contour of the latent-heat body (52) corresponds essentially to that of the insole (51).

30. Insole according to Claim 29 or in particular those that follow, characterized by the fact that additional layers of material, particularly foam, rubber and/or textile fabric layers, are attached to the upper side and/or the lower side of the latent-heat body (52).

31. Vest (54) with latent-heat bodies (55, 56, 57), which exhibit one or more of the characteristics according to Claims 1 to 20, characterized by the fact that the latent-heat bodies are sewn between the inner and outer fabric layers of the vest.

32. Latent-heat body designed as a storage element (58) for building construction, which exhibit one or more of the characteristics according to Claims 1 to 20, characterized by the fact that the carrier material (59) exhibits a lattice structure and is permeable to diffusing water vapor.

33. Solar evaporator (62) with one or more latent-heat bodies /53
as storage elements, in which case the latent-heat bodies exhibit

one of more characteristics of Claims 1 to 20, characterized by the one or more latent-heat bodies are arranged in a surrounding liquid in an internal housing (63) that exhibits an inlet line (71) for a gas, an outlet line (72) for the conveyance of gas charged with liquid to a consumer (73) and a covering (64) permeable to energy-rich radiation.

34. Solar evaporator (62) according to Claim 33 or in particular those that follow, characterized by the fact that the gas is air.

35. Solar evaporator (62) according to one or both of the Claims 33 and 34 or in particular those that follow, characterized by the fact that the liquid (67) is water,

36. Solar evaporator (62) according to one or more of the Claims 33 to 35 or in particular those that follow, characterized by the fact that the consumer (73) is a composter.

37. Solar evaporator (62) according to one or more of the Claims 33 to 36 or in particular those that follow, characterized by the fact that a safety valve (68) is provided to maintain a preselected liquid level in the outer housing (63).

38. Beverage cooler (74) with a container part (77) that /54 receives a beverage (76) in a beverage container (75), especially a bottle or can, characterized by the fact that the container part (77) contains latent-heat storage material (78) based upon paraffin.

39. Beverage cooler (74) according to Claim 38 or in particular those that follow, characterized by the fact that an opening in the container part (77) is closed by film (79) impermeable to latent-heat storage material (78), where one side of the film (79) is in contact with the latent-heat storage material (78), the side turned away from the latent-heat storage material (78) lying up against the beverage container (75).

40. Beverage cooler according to Claim 38 or in particular those that follow, characterized by the fact that the latent-heat storage material (78) is enclosed in a bag consisting of a film (79) impermeable to latent-heat storage material (78), the side of the film (79) turned away from the latent-heat storage material (78) lying up against the beverage container (75).

41. Beverage cooler according to Claim 39 or Claim 40 or in particular those that follow, characterized by the fact that the film is produced from an easily deformable material.

42. Beverage cooler according to one or both of the Claims 39 and 41 or in particular those that follow, characterized by the fact that the film (79) has a larger surface than the opening of the container (77).

43. Latent-heat body (1) according to one or more of the Claims 1 to 20 or in particular those that follow, characterized by the fact that the latent-heat body (1) contains a plurality of latent- /55 heat partial bodies (84), in which case a latent-heat partial body (84) contains a carrier-material part (85) and the latent-heat storage material (78) absorbed into the capillary-like recesses of the carrier-material part (85).

44. Latent-heat body (1) according to Claim 43 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) are enclosed by a common envelope that exhibits in particular one or more of the Claims 4 to 6.

45. Latent-heat body (1) according to one or both of the Claims 43 and 44 or in particular those that follow, characterized by the fact that the volume ratio of latent-heat bodies (1) to latent-heat partial bodies (84) possesses a value of at least ten.

46. Latent-heat body (1) according to one or more of the Claims 43 to 45 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) exhibit a wrapper (3) that exhibits in particular one or more of the Claims 4 to 6.

47. Latent-heat body (1) according to one or more of the Claims 43 to 46 or in particular those that follow, characterized by the fact that the latent-heat body (1) contains latent-heat partial bodies (84) of different sizes.

48. Latent-heat body (1) according to one or more of the Claims 43 to 47 or in particular those that follow, characterized by the fact that the latent-heat body (1) contains latent-heat partial bodies (84) with different shapes.

49. Latent-heat body (1) according to one or more of the Claims 43 to 48 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) have an elongated shape. /56

50. Latent-heat body (1) according to one or more of the Claims 43 to 49 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) have a flake-like form.

51. Method for the production of a latent-heat body (1) with paraffin-based latent-heat storage material (78) absorbed into the recesses of a carrier material, characterized by the fact that the latent-heat storage material is liquefied and that the previously liquefied latent-heat storage material (78) is introduced into recesses of the carrier material (86) with self-activating suctional force.

52. Method according to Claim 51 or in particular those that follow, characterized by the fact that the carrier material (86) is assembled from individual carrier-material elements, for example, by cementing, capillary-like recesses being formed in each case between the carrier-material elements.

53. Method according to one or both of the Claims 51 and 52 or in particular those that follow, characterized by the fact that the carrier material (86) saturated with latent-heat storage material (78) is subdivided into a plurality of latent-heat partial bodies (84).

54. Method according to Claim 53 or in particular those that follow, characterized by the fact that the separation of the saturated carrier material (86) takes place by sawing and/or cutting and/or tearing. /57

55. Method according to one or more of the Claims 50 to 54 or in particular those that follow, characterized by the fact that the latent-heat bodies and/or the latent-heat partial bodies (84) are pressed.

56. Method according to one or more of the Claims 50 to 55 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) are provided with a covering (3).

57. Method according to one or more of the Claims 50 to 56 or in particular those that follow, characterized by the fact that the latent-heat partial bodies (84) of the latent-heat body (1) are provided with a common enveloping covering (3).

58. Method according to one or more of the Claims 57 or in particular those that follow, characterized by the fact that the pressing operation takes place in common for a plurality of latent-heat partial bodies (84) in the shared covering (3).

59. Latent-heat body according to one or more of the Claims 1 to 20 and/or 3 to 50 or in particular those that follow, characterized by the fact that a microwave-active substance is contained in the latent-heat bodies.

60. Latent-heat bodies according to Claim 59, characterized by the fact that the microwave-active substance is uniformly distributed in the latent-heat body.

61. Latent-heat body according to one or both of the Claims 59 and 60 or in particular those that follow, characterized by the fact that the carrier-material elements contain the microwave-active /58
substance.

62. Latent-heat body according to one or more of the Claims 59 to 61 or in particular those that follow, characterized by the fact the microwave-active substance is contained in the capillary-like recesses.

63. Latent-heat body according to one or more of the Claims 59 and 62 or in particular those that follow, characterized by the fact the microwave-active substance is contained in the capillary-like recesses between the latent-heat partial bodies.

64. Latent-heat body according to one or more of the Claims 59 to 63 or in particular those that follow, characterized by the fact the microwave-active substance exhibits a powder-like form.

65. Latent-heat body according to one or more of the Claims 59 to 64 or in particular those that follow, characterized by the fact the microwave-active substance exhibits a granulate-like form.

66. Latent-heat body according to one or more of the Claims 59 to 65 or in particular those that follow, characterized by the fact the microwave-active substance exhibits a fiber-like form.

67. Latent-heat body according to one or more of the Claims 59 to 66 or in particular those that follow, characterized by the fact the microwave-active substance exhibits a lattice-like form.

68. Latent-heat body according to one or more of the Claims 59 to 67 or in particular those that follow, characterized by the fact that the microwave-active substance is a liquid at the working /59
temperature of the latent-heat body.

69. Latent-heat body according to one or more of the Claims 59 to 68 or in particular those that follow, characterized by the fact the microwave-active substance is selected from one or more of the material groups: glasses, plastics, mineral substances, metals, carbon, ceramic.

70. Method according to one or more of the Claims 51 to 58 or in particular those that follow, characterized by the fact that a microwave-active substance is added to the latent-heat body.

71. Method according to Claim 70 or in particular those that follow, characterized by the fact that the microwave-active substance is uniformly distributed in the latent-heat body.

72. Method according to one or both of the Claims 70 and 71 or in particular those that follow, characterized by the fact that the microwave-active substance is added to the carrier-material elements during their manufacture.

73. Method according to one or more of the Claims 70 and 72 characterized by the fact that the microwave-active substance is embedded during the assembly of the carrier material from carrier-material elements in capillary-like recesses thereby formed.

74. Method according to one or both of the Claims 70 and 73 characterized by the fact that the microwave-active substance is embedded in hollow spaces between latent-heat partial bodies.

75. Method according to one or more of the Claims 70 to 74, /60
characterized by the fact that the microwave-active substance is

added to the latent-heat storage material before the latent-heat storage material is conveyed to the capillary-like recesses of the carrier material.

Fig. 1

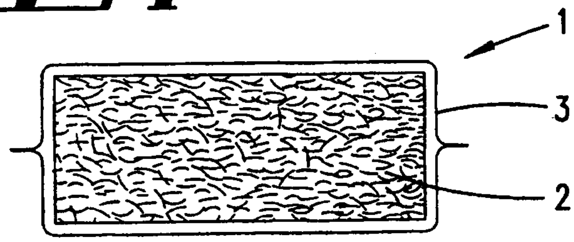


Fig. 3

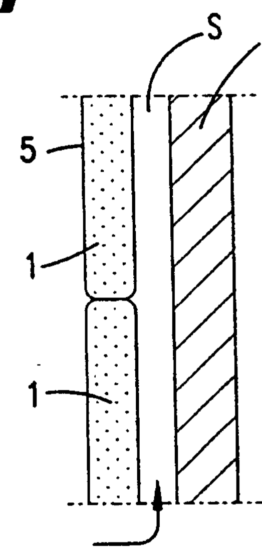
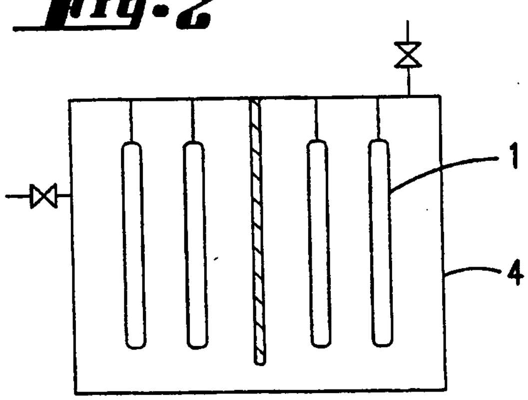


Fig. 2



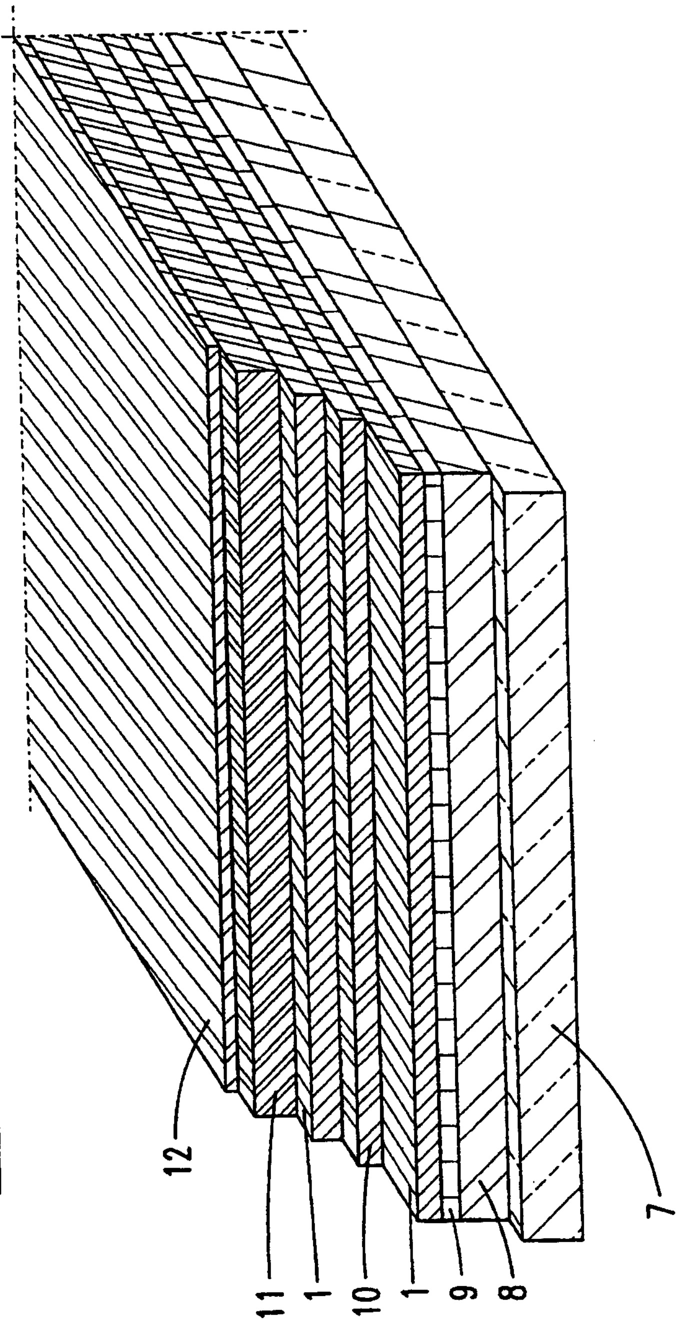


Fig. 4

Fig.5

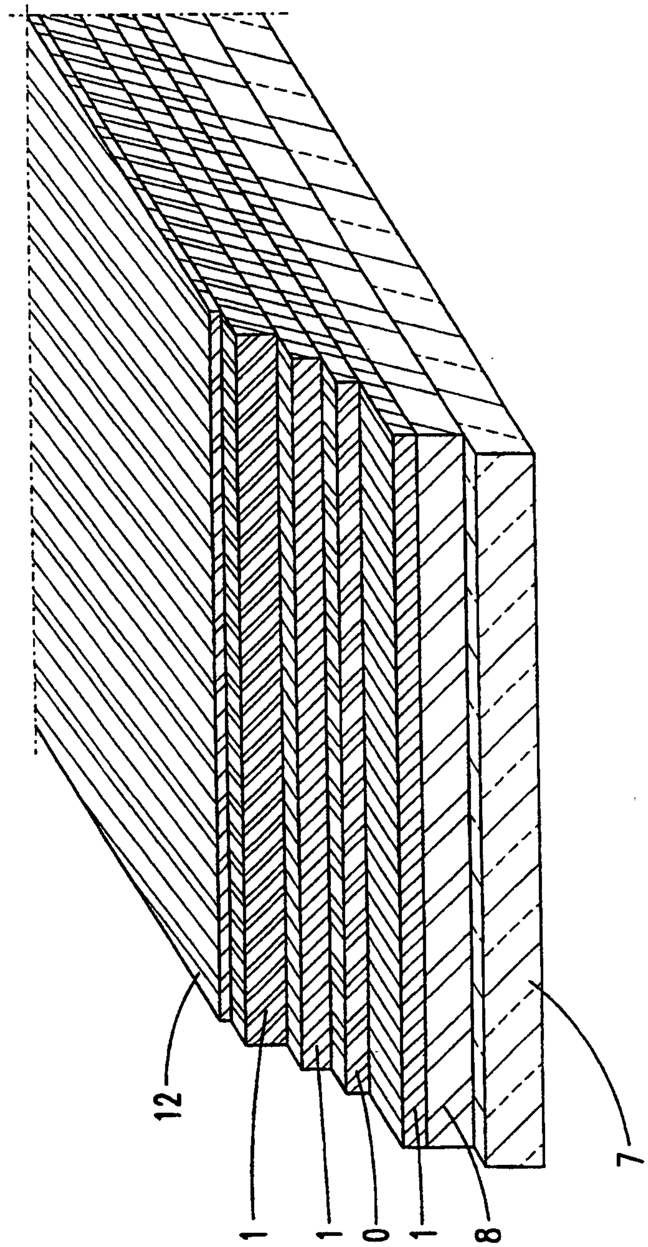


Fig. 6

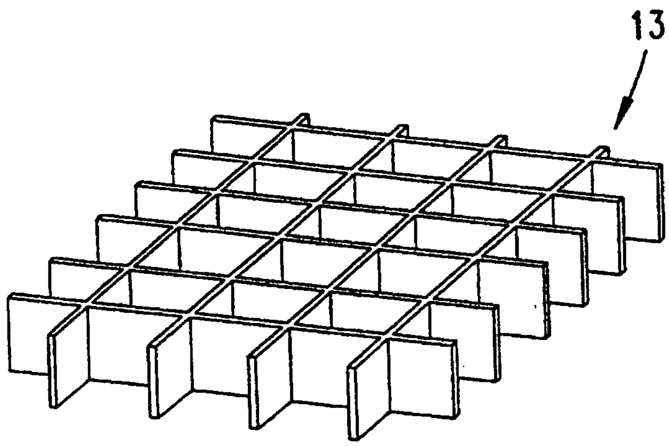


Fig: 7

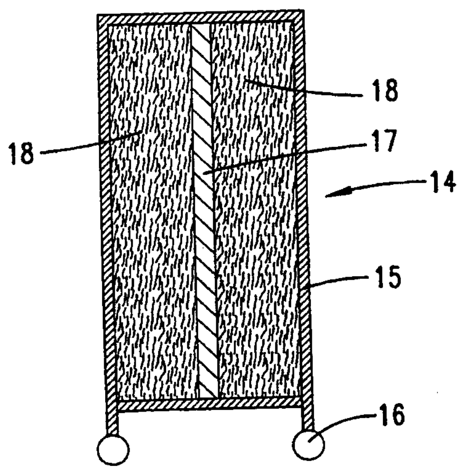
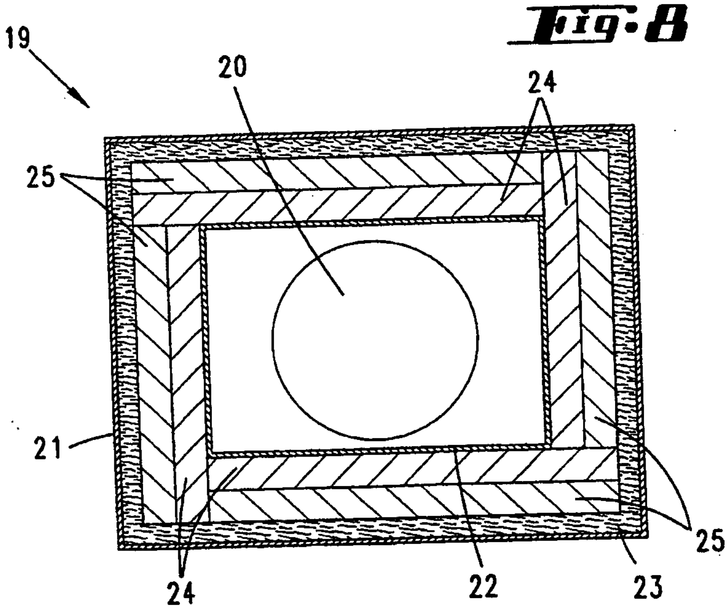


Fig: 8



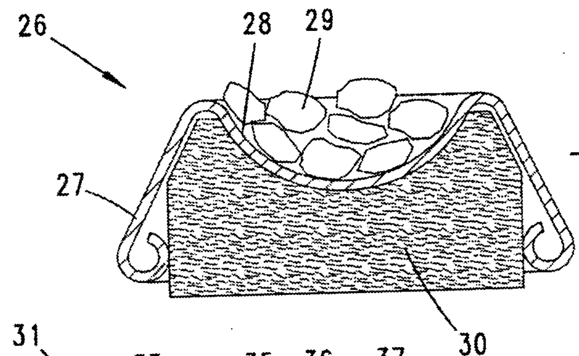


Fig. 9

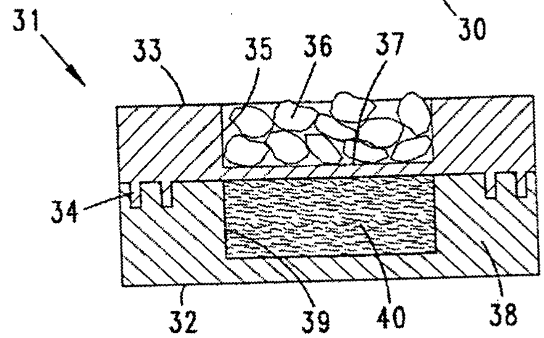


Fig. 10

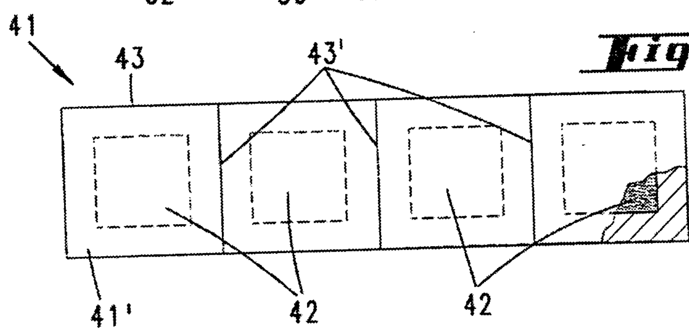


Fig. 11a

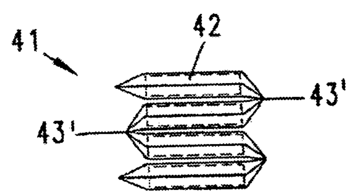
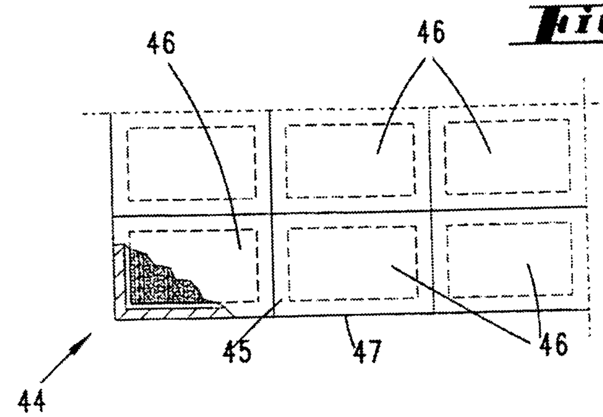


Fig. 11b

Fig. 12a



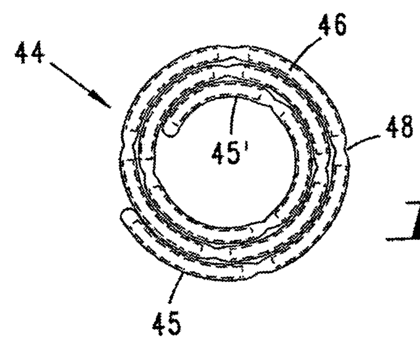
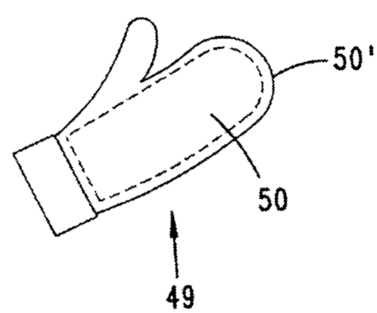


Fig. 12b

Fig. 13



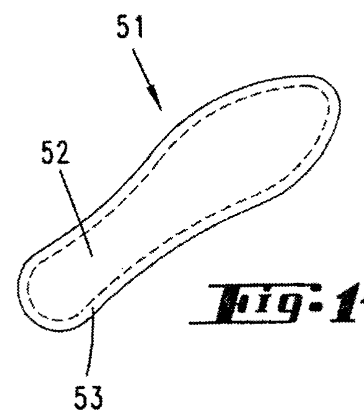


Fig. 14

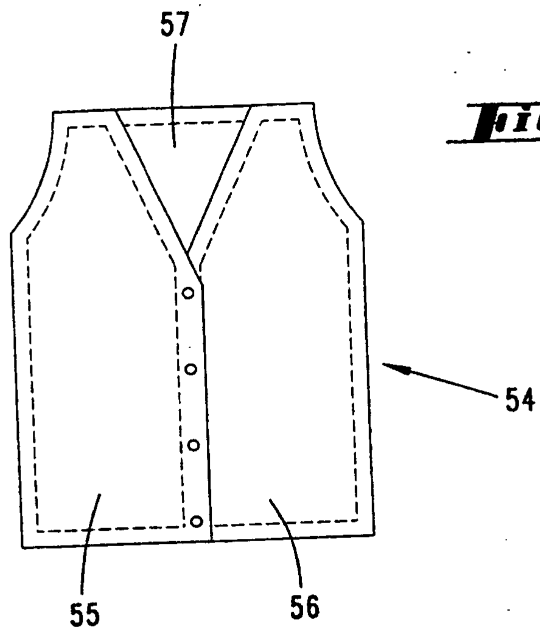


Fig. 15

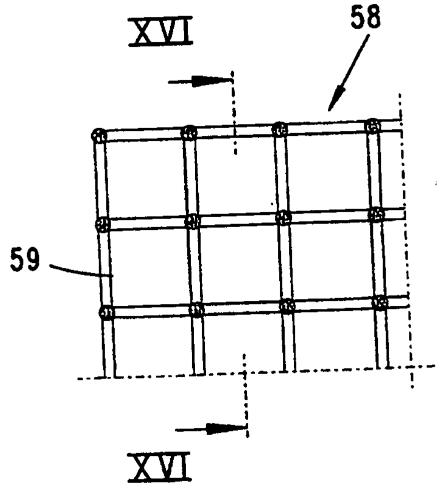


Fig. 16a

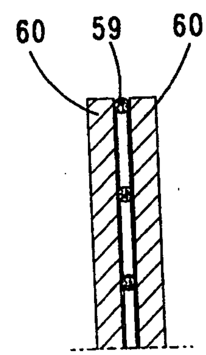


Fig. 16b

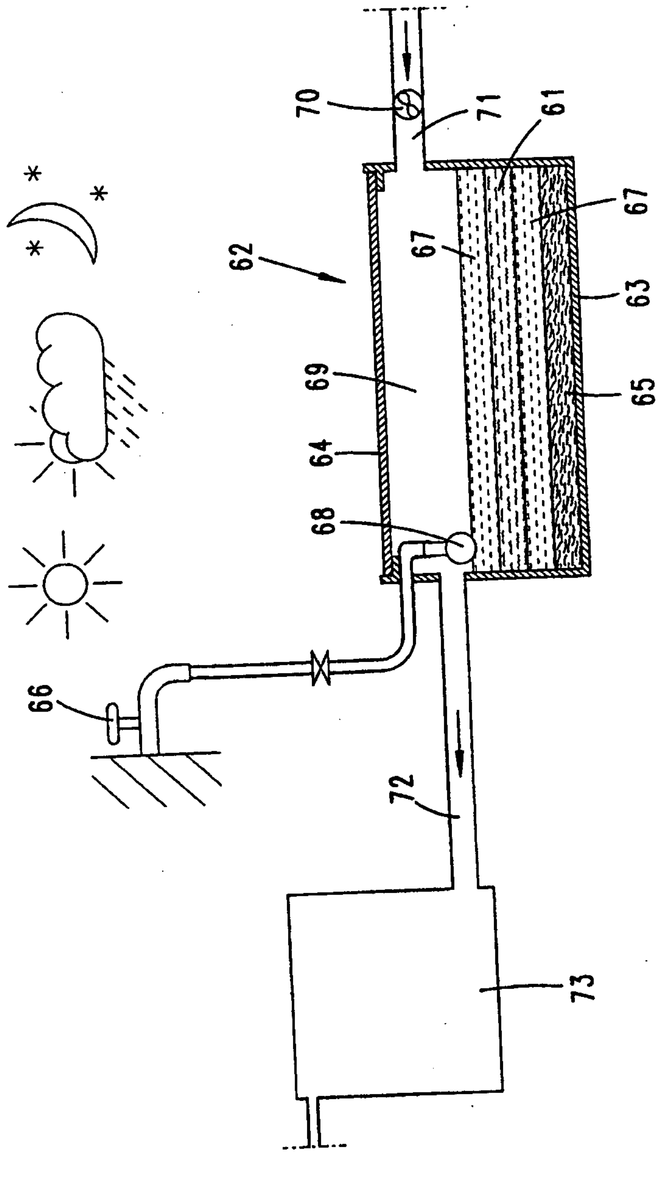


Fig.17

Fig. 18

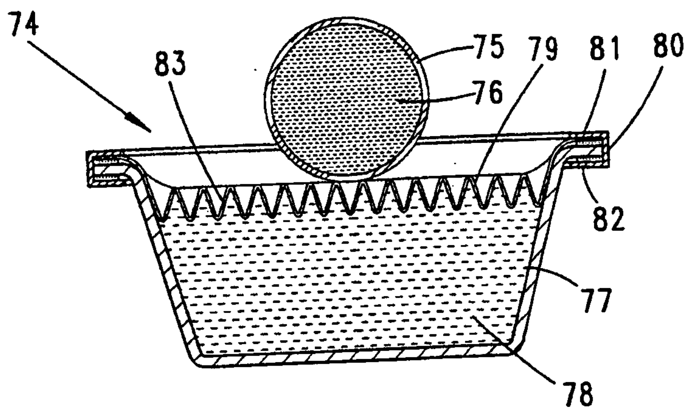


Fig. 19

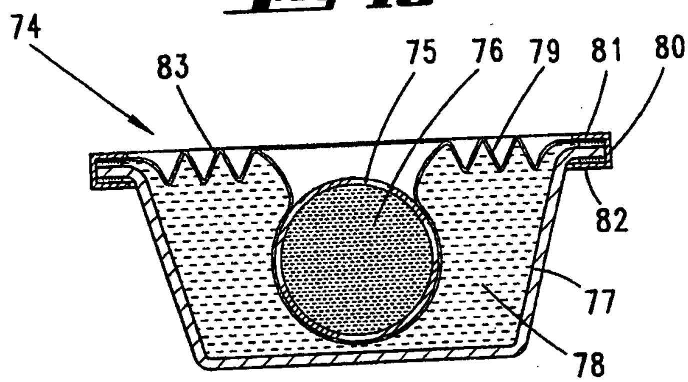


Fig. 20